UNITED PLANTERS' ASSOCIATION OF
SOUTHERN INDIA

SCIENTIFIC DEPARTMENT

(TEA SECTION)

ANNUAL
ADMINISTRATION REPORT
FOR
1958–1959

NSP
RAM
MM

COMMONWEALTH MYCOLOGICAL INSTITUTE
8 - SEP 1959

The Oriental Press, Coonoor.

NOTE:

Specimens for laboratory examination should be sent by *unregistered* post to

The Officer-in-Charge,
UPASI Tea Experiment Station,
Devarshola P. O.,
Nilgiris.

In the case of specimens too bulky to send by post, they should be sent by rail to Ootacamund and the Rail Receipts or parcel Way Bills sent to

The Rajalakshmi Motor-Service,
Ootacamund,

for collection and forwarding to Devarshola.

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SOUTHERN INDIA

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ANNUAL
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FOR
1958—1959

TEA PRODUCT SUB-COMMITTEE

(Upto August 1958)

Mr. L. W. Russell	*Chairman*
Mr W. W. Mayne	*Member*
Mr. W. C. F. Simmonds	*Member—Resigned—June 1958*
Mr M. M. Varghese	,,
Mr. C. I. Machia (*President, UPASI*)	,, —*Ex-Officio*
Mr. H. C. Kothari (*Vice-President, UPASI*)	,, —*Ex-Officio*
Mr. N. S. G. Bannatine	,, —*From June 1958*

TEA PRODUCT SUB-COMMITTEE

(From September 1958)

Mr. P. S. M. Molyneux	*Chairman*
Mr. A. M. B. Clarke	*Member—Resigned February 1959*
Mr. C. H. S. London	,, —*From March 1959*
Mr. M. M. Varghese (*President, UPASI*)	,, —*Ex-Officio*
Mr. L. W. Russell (*Vice-President, UPASI*)	,, —*Ex-Officio*

AD HOC RESEARCH SUB-COMMITTEE

(From September 1958)

All Members of the Tea Product Sub-Committee and

Mr. E. J. C. Menzies	*Member*
Mr. M. C. A. Jackson	,,
Chairman, Tea Board	,,

SCIENTIFIC DEPARTMENT

Technical Staff

Mr. S. Ananda Rau, M.Sc.	*Chief Scientific Officer*
Mr. V. Jayaraman, B.A., B.Sc. (Ag.)	*Chemist*
Dr. K.S. Venkataramani, M.Sc., Ph.D., F B.S.	*Botanist—Resigned January 1959*
Mr. G. N. Joshi, B Sc. (Ag)	*Agronomist*
Dr. C. S Venkata Ram, M.Sc., Ph.D.	*Plant Pathologist*

Office Staff

Mr. K. I. Abraham	*Clerk—Devarshola*
Mr. D. Arunachalam	*Clerk—Coonoor*

Field Staff

Mr. E. Powell	*Field Recorder*

Laboratory Attenders

Mr. P. Sankaran Nair
Mr. K. Madhavan Chetty
Mr. P. Ahmed Kutty

LIST OF CONTENTS

	Page
Report of the Chief Scientific Officer	1
Meteorological Data	8
Report of the Soil Chemist	9
Report of the Botanist	13
Report of the Plant Pathologist	22
Appendix	27

United Planters' Association of Southern India.

ANNUAL REPORT OF THE UPASI SCIENTIFIC DEPARTMENT

TEA SECTION

For 1st April 1958—31st March 1959

REPORT OF THE CHIEF SCIENTIFIC OFFICER

PART I—ADMINISTRATION

The Chief Scientific Officer moved his headquarters from Devarshola to Coonoor on 1st April 1958 and Mr. V. Jayaraman, Soil Chemist, was appointed to act as the Officer-in-Charge of the Tea Experiment Station, Devarshola.

Dr. C. S. Venkata Ram, M SC , PH.D., was appointed as Plant Pathologist and he joined duty on 2nd April 1958. He was posted to Devarshola and has continued to work there throughout the year.

Dr K S. Venkataramani tendered his resignation to the post of Botanist and left the service of the UPASI in the middle of January 1959.

Mr. G. N Joshi, Agronomist, who was posted to the High Range for training, continued to work at the Scientific Department of the Kannan Devan Hills Produce Co , Ltd., at Munnar until the end of the year when he resigned his appointment.

The post of Entomologist remained unfilled throughout the year, mainly owing to the difficulty in securing suitable accommodation.

Tea Experiment Station, Devarshola: No additions or alterations were made to the Tea Experiment Station during the year. In addition to usual upkeep, some urgent repairs were called for owing to the unsatisfactory condition of several buildings and these were carried out during the year.

Climatic conditions for most part of the year was favourable for the growth of tea, although the dry weather months were much drier than normal. This feature did not materially affect the year's crop, but these months were the beginning of what proved to be the most severe drought within recent years which considerably reduced production in the succeeding months. The rainfall during the year was 70.73 inches distributed over 154 days as against 66.04 inches on 136 days in 1957/58. The maximum temperatures were much higher than normal in the months of January, February and March 1959.

The crop for the year from the 13 acres of tea in bearing has again been the highest on record. 91,376 lbs. of green leaf were harvested as against 82,995 lbs. in the previous year, thus registering an increase of 8381 lbs. This increase, despite the electricity cut which necessitated stoppage of plucking for nearly 3 weeks in June 1958 and a labour strike, lasting for nearly a week in January 195', on Woodbriar Estate which was buying our green leaf, is indeed very gratifying. Based on an average out-turn of 23%, the quantity of green leaf harvested on the Station represents an average yield of 1616 lbs. made tea per acre for the year. By the sale of the year's crop at 22 nP per pound a sum of Rs. 20093.92 was realised.

The monthly distribution of crop during the year was as follows:

MONTHLY CROP STATEMENT

		Lbs /green leaf	Average for past 5 years Lbs. green leaf
April	1958	5,155	3,765
May	,,	11,989	6,809
June	,,	4,326	7,282
July	,,	9,118	7,826
August	,,	11,108	6,937
September	,,	10,050	8,028
October	,,	10,200	9,321
November	,,	11,752	6,246
December	,,	6,024	4,512
January	1959	5,635	3,261
February	,,	3,575	2,262
March	,,	2,444	2,621
		91,376	68,870

Correspondence: The correspondence handled at the Station was somewhat smaller than that in the previous year due mainly to the Chief Scientific Officer having shifted his headquarters to Coonoor. This decrease at the Station was more than offset by the considerably larger volume of correspondence dealt with at Coonoor. The technical enquiries dealt with at Devarshola and at Coonoor together registered a small increase over those of the previous year.

Publications: The members of the technical staff contributed, jointly and severally, five papers to journals during the year. The titles of these articles are given in the reports of individual officers which follow.

Three articles, all related to work on Blister Blight control carried out during the year, are included in the Appendix to this report.

Touring: The following tours were undertaken during the year:—

April 1958	— High Wavys Group Estates, Madurai District.
May	— ... ...
June	— Adderley and Curzon Estates, Nilgiris.
July	— Central Travancore Planters' Association Estates.
August	— Anamallais.
September	— Glendale and Thiashola Estates, Nilgiris.
October	— Farm Tea, Parkside, Nonsuch and Prospect Estates, Nilgiris, and Attikunta Estate, Nilgiri-Wynaad.
November	— Ceylon.
December	— Brooklands, Nonsuch and Glenmorgan Estates, Nilgiris and The Kannan Devan Hills Produce Co. Estates, High Range.
January 1959	— Central Travancore Planters' Association Estates, Prospect, Terramia and Parkside Estates, Nilgiris, and Mysore Planters' Association Estates.
February	— ... ...
March	— Prospect and Kilmelfort Estates, Nilgiris.

In addition to the above, the Chief Scientific Officer, accompanied by the Soil Chemist, paid a visit to the Kumili-Devicolam road area in order to investigate the suitability of this area for growing tea. This visit was undertaken at the request of the Tea Board to whom a report was made.

UPASI Exhibition: The main theme of the exhibits of the Scientific Department at the 1958 UPASI Exhibition related to problems in management of tea nurseries. The various diseases and pests and other disorders to which the nursery plants are subject were demonstrated on living tea plants specially grown in pots.

Annual Conference of the Scientific Department: Owing to depleted staff, this Conference, usually held in March each year, could not be organised in the year under report.

Research Expansion Scheme: Despite efforts made to expedite acquisition of the land in the Anamallais, unforeseen difficulties arose which protracted negotiations with the Madras Government on the one hand and the Tea Board on the other. Payment of the value of the land, as fixed by the Government, has been made, but the Sale Deed in respect of the land has not been finalised yet. It is hoped that permission to enter upon the land would shortly be granted by the Madras Government and that building construction would commence during the coming year. The plans and quantity estimates for the various buildings have been prepared by the Architects and are ready to go out to tender.

The Sale Deed in respect of the Sub-Station area in Vandiperiyar purchased from Messrs. Malayalam Plantations Ltd. has been completed and the area has been fenced in temporarily in view of the threat of squatters. The commencement of work on this Station was scheduled to take place in 1960/61 but the Tea Board has now been approached to advance the allotment of grant for this Station by a year, so that the work of this Station could be undertaken in 1959/60 itself.

Boards and Committees: The Chief Scientific Officer represented the UPASI and served on the following Boards and Committees:

1. Board of Agriculture and Animal Husbandry in India—Crops and Soils Wing.
2. The Nilgiri District Soil Conservation Board.
3. Fertilisers and Pest Control Products Sub-Committees and the Agriculture and Food Products Division Council of the Indian Standards Institution.
4. Tea Research Liaison Committee of the Tea Board.

In connection with the above, he attended three meetings of the Nilgiri District Soil Conservation Board, two in Coonoor and one in Ootacamund, and four meetings of the Tea Research Liaison Committee of the Tea Board held in Calcutta. None of the meetings convened by the Indian Council of Agricultural Research and the Indian Standards Institution were attended during the year.

In the absence of Mr. D. C. Kothari, the Chief Scientific Officer represented the UPASI at the meeting of the Madras State Soil Conservation Board held in Ootacamund in May 1958.

The Chief Scientific Officer also attended a meeting arranged by the Tea Board in February 1959 in Calcutta for considering the fertilisers distribution to the tea industry in 1959/60.

Tea Board Research Liaison Committee: In this Committee, several schemes of research on tea were considered during the year and the ones of particular interest to the South Indian tea industry which have started functioning with financial aid from the Tea Board are (1) the biological control of mites and flushworm at the Commonwealth Institute of Biological Control, Bangalore Branch, (2) micro-fauna of tea soils at the Kerala University and (3) investigations on *Helopeltis* at the University of Calcutta. Nutritional investigations on tea and investigations on chemical standards for tea, initiated in previous years, have continued to make progress.

Visitors: In addition to representatives of commercial organisations, both Indian and overseas, who visited Coonoor and Devarshola from time to time, we were pleased to welcome during the year the following visitors:

Russian Scientific Delegation, headed by Mr. Nicolai T. Rosinishvilli, Chief of the Tea Section, Ministry of Food Industry, USSR, Mr. Flemal, Agronomist, from Belgian Congo, Messrs. Keegel and Kehl, Tea Technologist and Vegetative Propagation Officer respectively, from the Tea Research Institute of Ceylon, Dr. D. N. Barua, Plant Physiologist at the Tocklai Experiment Station, Assam, Dr. Urquhart, Cocoa Development Officer, Government of India, Mr. Fazlulla Khan, Spices Development Officer, Government of India, Dr. Kellogg, American Consultant to the Government of India and Officers of the Soil Conservation Scheme, the Collector of Nilgiris, Dr V. P. Rao, Entomologist-in-Charge of the Bangalore branch of the Commonwealth Institute of Biological Control, the Director and other Officers of the Madras Cinchona Department and Officers of the Central Food Technological Research Institute, Mysore.

At the request of the Indian Standards Institution, three probationary Assistant Directors of that institution were received for imparting in-field training to them in all aspects of tea culture and manufacture.

PART II - RESEARCH AND ADVISORY

A perusal of the previous annual reports will show that it has been repeated year after year that much of the time of the officers of the Department is taken up by advisory work. The year under report was no exception. Nevertheless, blister blight control trials, usually undertaken every season, were carried out with new formulations of fungicides and considerable time of the Botonist was devoted to work on growth studies, vegetative propagation and weedkillers. The Plant Pathologist was engaged in studies on blister blight spore density fluctuations throughout the season as a possible means of forecasting disease incidence. He has also started a study of the effect of soil fumigants on root disease fungi. The time of the Soil Chemist was fully occupied with the analysis of soils and manures, evaluation of fungicides and insecticides and conduct of field experiments in progress, in addition to supervision of the work connected with the running of the Station.

Manuring: The effect of cessation of manuring was commented on in the last annual report. That stopping manuring leads to a rapid decline in yield and deterioration of the health of the bush is fully borne out by this year's yield figures.

The soil amendment trials in which 200 lbs. of phosphoric acid and 600 lbs. of potash per acre were applied once in 3 years in addition to the normal yearly application of NPK fertiliser mixture have shown that these large applications of P and K have not had any significant effect on yield over a period of 7½ years. It was therefore decided to terminate these trials.

A significant feature revealed in another fertilisers trial was the depressing effect on yield produced by potash at 60 lbs./acre applied alone. Whether this reduction in yield is the direct effect of potash or is attributable to absence of nitrogen needs to be further investigated.

Blister Blight: The results of screening trials carried out with various formulations of fungicides are fully reported in a separate article published in the Appendix to this report.

Two other aspects of blister blight control studied during the year were : (1) the effect of lengthening of the spraying rounds on the incidence of disease and (2) measurement of fluctuations in spare density as a means of forecasting disease incidence. Accounts of these studies are to be found in the Appendix and in the report of the Plant Pathologist.

Weedkillers: A few exploratory trials carried out by the Botanist have revealed that Dowpon (Dalapon) is a promising weed-killer for the eradication of grass in tea. Its defoliant effect on standing Dadap trees is worthy of note. Further work on this product is planned for the coming year.

Growth Studies: The development of plucking shoots and the effect of the length of plucking rounds on yield formed subjects of detailed study, and the results of observations are recorded in the Botanist's report.

Pests and Diseases: Mites have continued to pose a serious problem and their attacks have been prevalent in all the tea districts. Control is generally achieved by the use of wettable sulphur formulations and of Akar 338. The tolerance limit for the latter in tea has not been fixed yet, though, based on residue analysis figures, it seems probable that 5 p.p.m. will be accepted as the limit.

It is of interest to mention here that the Bangalore branch of the Commonwealth Institute of Biological Control has recently started work on a scheme, Financed by the Tea Board, of survey of parasites and predators affecting mites and Flushworm.

Shot-hole borer in the Vandiperiyar area had until last year been considered as of minor importance as no appreciable spread nor serious damage had occurred so far. Evidence is now becoming available that this view will soon have to be changed. It has now come to light that die-back and death of individual branches and sometimes of the whole bush after pruning are invariably associated with Shot-hole borer attack. Damage of an alarming extent was reported from one estate in the Vandiperiyar area and the situation created by this borer needs a thorough survey and study, the plans for which are under way for execution in the coming year.

Flushworm, for no known reason, has come down from its epidemic status, though it could still be seen in large numbers in many areas, especially on tea coming in from pruning.

Thrips, Aphis, Grasshoppers and Borers were some of the pests the occurrences of which were reported during the year. They gave no cause for any great concern.

Enquiries relating to eelworm in tea nurseries was very prominent and a few instances of considerable damage involving the death of several thousands of plants came to notice. As pointed out so often in previous reports, eelworm control is more of a preventive nature rather than being remedial and the importance therefore of prophylactic treatment of nursery soil cannot be too strongly emphasised.

Of the diseases of fungal origin, *Macrophoma theicola* causing "branch canker" and *Leptothyrium theae* causing die-back of shoots were fairly commonly reported. An instance of widespread "collar-rot" of young clonal tea plants in new clearings was investigated which revealed that the fungus *Rhizoctonia solani* was associated with the trouble, the factors predisposing the plants to fungal infection being considered to be deep planting and mulching.

The effect of certain soil fumigants on root disease fungi was under study by the Plant Pathologist and his preliminary findings indicate that these fumigants can effectively kill the fungi lodged in the host root in the soil.

Acknowledgements: During the year the Department received considerable assistance from all sections of the planting industry and commercial organisations connected with planting. Grateful acknowledgements are made to all of them and, in particular, to the Tea Product Sub-Committee and the Secretariat of the UPASI.

Cordial relations have continued to exist between us and our sister organisations, the Indian Tea Association Scientific Department in Assam and the Tea Research Institute of Ceylon, and we are extremely grateful to them for all the co-operation and assistance we have received.

Our contacts with the Central Food Technological Research Institute in Mysore and the Research Department of the Coffee Board have become much closer than ever before. The assistance we have received from them in various ways is gratefully acknowledged.

In conclusion, I should like to take this opportunity to express my colleagues' and my gratitude to the managers of estates visited during the year for help and hospitality which they extended to us.

S. Ananda Rau,
Chief Scientific Officer.

METEOROLOGICAL DATA

(1958—1959)

Months.		Rainfall in inches.	No. of days with rain.	Air.		Soil.*		Humidity.		Vapour Pressure.		Cloud.	
				Average noon maximum.	Average overnight minimum.	8 30 A. M.	3 00 P. M.	8.30 A. M.	3.00 P. M.	8.30 A. M.	3.00 P. M.	8.30 A. M.	3.00 P. M.
April	1958	3.14	11	85.4	65.2	80.8	84.4	87.7	65 3	24.2	23.5	...	...
May	,,	9.05	21	81.6	65.3	80.9	83.0	92.8	80.7	24.4	26.7	1.6	2.2
June	,,	7.43	16	76.2	65.4	79.4	81.4	90.6	83.6	22.4	23.8	4.4	4.5
July	,,	21.19	28	73.5	64.4	75.4	77.1	94 8	90.2	21.8	23.5	6.3	5.7
August	,,	10 80	31	74.6	64.4	77.4	78.8	96.2	91.2	22.3	24.3	5.8	5.4
September	,,	3.88	17	78-3	62.3	77.8	79.1	91.8	81.5	21.3	24.3	1.7	1.2
October	,,	8.87	19	78.5	63.3	77.4	78.8	94.2	81.0	22.6	24.0	1.6	2.6
November	,,	6.37	11	78.3	63.0	76.5	78.0	96.3	75.5	22.0	23.1	1.0	1 0
December	,,	...	...	78.4	60.2	73.1	75.0	94.6	64.6	18.9	20.1	...	...
January	1959	...	...	82.4	59.0	72.4	75.4	96.3	53.2	18.5	18 6	...	...
February	,,	...	...	86.7	60.3	74.8	81.7	94.1	41.5	19.4	16.8	...	...
March	,,	...	...	89.3	61.3	79.4	88.5	85.8	33.9	19.8	14.8	...	...
TOTAL		70.73	154										

* at 1 foot depth

REPORT OF THE SOIL CHEMIST

(1958—1959)

Advisory and Research :

In connection with advisory and research work, the following samples were analysed during the year.

Soils		257
Manures and Manure Mixtures	...	53
Fungicides	...	16
Insecticides	...	3
Tea Flush	...	38
Rubber Leaves	...	28
Made Tea	...	5
Tea Waste	...	1
Total Number of Estimations	...	1087

Thirty-five general enquiries on several aspects of tea cultivation were attended to.

Soils :

As during the previous years, majority of the soil samples were tested for organic matter and pH value to determine their suitability for use in nurseries. Soils from areas to be replanted were also examined with the same object. Stunted growth, "bitten off" condition and, in some cases, death of seedlings could be definitely traced to either neutral or alkaline reaction of the soil or severe attack of root-knot eelworm. Attention has already been drawn in the previous annual reports to the necessity of having the soils tested in advance for freedom from eelworm infestation and for suitable soil reaction and stress is laid again on this point in the current report. Indiscriminate use of wood ashes, cattle urine and urine earth will lead to alkaline reaction of the soil. If the set-back in growth is not far advanced, the soil could be treated with sulphur to increase the acidity or the seedlings transferred to fresh baskets with suitable soil. Treatment against eelworm in basket nursery can be done by heating the soil for 5 minutes up to about 60°C., i.e., till the soil is somewhat too hot to handle comfortably Soil fumigants can be used for bed nurseries.

Manures and Manure Mixtures :

Most of the samples analysed conformed to the guaranteed analysis. In some instances, due to improper method of sampling and packing, discrepancies between laboratory and guaranteed analyses arose. Correct sampling procedure should be adhered to and details of this are given in the Advisory Leaflet No. 2 of the Scientific

Department. Mixtures containing urea and ammonium sulphate nitrate absorb moisture very quickly, especially during damp weather. All samples should be sent in tins securely packed and not in paper or hessian bags.

Fungicides and Insecticides :

Fungicides were tested for total copper, suspension and rainfastness. Those which were received for examination were found to be very satisfactory. Keeping quality of an oxychloride fungicide was very good, identical figures for suspension being obtained at the beginning and at the end of six months of storage. Full details of methods of laboratory evaluation of fungicides and insecticides were given to a chemical and manufacturing concern in Kerala. The analysis of tea flush and rubber leaf samples, dusted and sprayed with copper formulations, for copper content, the analysis of tea flush samples dusted with new fillers for silica content, the assessment of method of packing copper fungicides and the preparation of samples treated with an acaricide for residue analysis were carried out at the request of a plant protection firm. An oil-based copper fungicide was also tested to find whether its use would taint the manufactured tea.

Blister Blight Trials :

Full details of the season's trials in the control of blister blight are given in the Appendix.

Visits :

In addition to visits to neighbouring estates, I attended the UPASI Annual Meetings in Coonoor in August and the Field Day of the Coffee Research Sub-Station at Chethalli, Coorg, in November. In December, I accompanied the Chief Scientific Officer on a tour of Munnar and Central Travancore tea estates and also in a survey of the area between Devicolam and Kumili for prospective tea cultivation. While in Munnar, assistance was given to the Scientific Department, K.D.H.P. Co., Ltd., in the estimation of crude fibre in tea.

Field Experiments :

A. 27 Plot (3 x 3 x 3) Factorial Experiment—Tea Experiment Station.

The yield records of eight plots, four to study the effect of cessation of manuring and four to study the effect of continued withholding of phosphoric acid were continued to be maintained.

TABLE I

Cessation of Manuring

Yield per plot in lb. green leaf

April/March Cycle	Year	8	17	18	27	Plot Mean
II	III	686	493	615	730	631
III	III	646	451	644	733	619
IV	III	1057	693	853	1273	969
V	III	718	442	592	793	636
VI	III	532	197	326	519	394

TABLE II

Effect of withholding phosphoric acid

Yield per plot in lb. green leaf

April/March Cycle	Year	5	9	15	26	Plot Mean
II	III	444	557	476	433	478
III	III	470	511	487	446	479
IV	III	715	726	760	711	728
V	III	480	660	585	509	556
VI	III	375	825	620	626	612

As indicated in last year's report, ceasing to manure has resulted in considerable decline in yield. The bushes present a thin and defoliated appearance. Since definite proof has been obtained that stopping manuring leads to decline in yield and deterioration of the health of the bushes, it has been decided to revert to manuring these plots from the next season.

Withholding of phosphoric acid has not affected the yield so far.

B. 15 Plot (3 x 5 Randomised Block) Experiment—Tea Experiment Station.

The yield figures for this trial are given in Table III.

TABLE III

Yield in lb. green leaf

Nitrogen 60 lb./acre	Potash 60 lb./acre	Nitrogen + Potash 60 lb. + 30 lb./acre
1759	1086	1792

Application of potash only has resulted once again in significantly less yield than the other two treatments.

C. 25 Plot (5 x 5 Randomised Block) Experiment—High Range—Letchmi and Nullatanni Estates.

TABLE IV

lb. made tea per acre

	O	N	NP	NK	NPK	Sig. Diff. 5%
Nullatanni	560.0	767.9	804.6	733.9	911.0	211.2
Letchmi	507.1	479.0	397.4	630.7	845.1	170.2

On Nullatanni, nitrogen just falls short of significance. Nitrogen plus potash is not significant. The other two treatments have given significantly higher yields. On Letchmi, as during the previous years, only the complete mixture has given significantly higher yields.

D. Soil Amendment Trials.

The two trials on Daverashola and Mayfield Estates were continued.

TABLE V

Yield in lb. made tea per acre

	No Manure	Ammonium Sulphate	Amendment	NPK	NPK+ Amendment	Sig. Diff. 5%
Daverashola (excluding rested rounds)	753.3	1021.2	734.3	1107.5	1197.8	109.5
Mayfield				1159.6	1153.7	...

The addition of Amendment mixture to complete fertiliser has not produced any significant effect on the yield, beneficial or otherwise. This trial was started towards the end of 1951 and during seven and a half years Amendment mixture was applied thrice. In view of the fact that the Amendment has not had any effect on yield so far, it is proposed to discontinue the trial.

Acknowledgements :

The assistance and hospitality received from Managers of Estates visited is gratefully acknowledged.

V. JAYARAMAN,
Soil Chemist,

REPORT OF THE BOTANIST

(For the period April 1958 to January 1959)

General :

From the year 1948 the Botanist was in charge of work connected with the diseases of the tea bush and ancillary crops in addition to general botanical work. With the appointment of a Plant Pathologist in April 1958, the work of the Division of Botany was re-allocated and the Botanist was mainly concerned with the botanical aspects of tea culture and chemical control of weeds. He, however, assisted the new Plant Pathologist for a few months in connection with advisory work. In the absence of an Entomologist on the staff of the Tea Experiment Station during the year, the Botanist looked after, to some extent, the routine advisory work of entomological nature.

Dr K. S. Venkataramani was offered by the Government of Madras the post of Reader in Horticulture at the Postgraduate Institute of Agriculture in Coimbatore and he resigned from his post as Botanist and left the Tea Experiment Station in January 1959.

Touring :

The Botanist visited an estate on the Nilgiris in May 1958 in connection with an investigation into a large-scale die-back of tea bushes. The fungus *Leptothyrium theae* was found to be the cause of the die-back.

A visit was also made to a group of tea estates in Madurai District, again in May 1958, to investigate the cause of a widespread collar-rot of young clonal tea plants in clearings. It was found that the fungus *Rhizoctonia solani* was associated with the diseased tissues at the collar region. Two factors, namely, deep planting and injudicious mulching, were found to predispose the plants to fungal infection.

Publications :

The following articles were written :

1. A simple substitute for bell-jar (with Dr. C. S. Venkata Ram),
2. *Rhizoctonia* collar rot of tea (with Dr. C. S. Venkata Ram),
3. Responses of tea bushes to foliar application of fertilisers, and
4. A new species of *Cylindrocladium* parasitic on tea roots (with Dr. C. S. Venkata Ram).

Blister Blight :

The Botanist assisted the Plant Pathologist in carrying out some of the field experiments on the control of blister blight. Full details of these experiments will be furnished by the Plant Pathologist.

The bush which was highly resistant to blister blight for several years developed a mild infection a couple of years ago and it was then observed that a new physiological race of the fungus was responsible for the infection on that bush and the clonal plants raised from it. During the current year a fair amount of infection was noticed on the clonal plants. Although the bushes were left unprotected, severe damage was not caused.

Selection :

Selection of bushes for high yields was made from among the bushes on the Tea Experiment Station. Initially 76 bushes were marked by eye-judgement, which number was later reduced to 7 on the basis of weekly yield data (dry weight) obtained from the individual bushes over a period of 12 weeks. There was a positive relationship between the number of shoots produced and their weight and it appeared, therefore, that for selection purposes, the number of shoots produced alone would be a fair criterion, provided the bushes were of the same jat. The rooting capacity of these selected bushes is being studied.

Vegetative Propagation :

Studies on vegetative propagation of tea were continued. A brief account of the various aspects is given below.

(i) *Use of polythene cover in the nursery :*

It is now fairly well established that polythene film can be safely and beneficially employed in the nursery to conserve soil moisture, maintain humidity and prevent wind damage in the callusing beds. Details of the use of polythene have been given already elsewhere (Bulletins 17 and 18 of the UPASI Tea Scientific Department).

(ii) *Treatment with growth substances :*

Quick-dip treatment of the cuttings with growth substances such as indolylacetic acid (IAA), indolylbutyric acid (IBA) and naphthylacetic acid (NAA) have more often than not aided quicker callusing and rooting. Of these substances, when used alone, IBA gave the best results. A combination of IBA and NAA gave a better performance than either IBA or NAA. The results obtained from a pilot trial with a broad-leaf clone are summarized below :

Treatment.		Dry weight of roots (in gram) average per cutting.
1. Untreated (Control)	...	0.2023
2. IAA (10,000 p.p.m)	...	0.2027
3. IBA (10,000 p.p.m.)	...	0 2150
4. NAA (10,000 p.p.m.)	....	0.2107
5. IAA+IBA (5000 + 5000 p.p.m.)	...	0.2160
6. IBA+NAA (5000 + 5000 p.p.m.)	...	0.2257

Different growth substances affected differently not only the quality but also the quantity of the roots produced. Treatment with IBA, IAA, NAA and their combinations resulted in long and fibrous roots. Thick and brittle roots and a stunted root system were produced by treating the cuttings with very dilute 2, 4-dichlorophenoxyacetic acid (2, 4-D). 2, 4, 5-trichlorophenoxyacetic acid (2, 4, 5-T) was harmful even at high dilutions; treatment of the basal end of the cutting with this growth substance killed the tissue at that region, but callus formation and poor root development were noticed higher up on the stem portion. Indolylpropionic acid (IPA) produced stunted, irregular, thick and club-shaped roots. A mixture of IAA and IBA, and IBA and NAA in equal proportion (5 mg. of each per ml. of 50% alcohol) produced a greater number of roots than IAA, IBA or NAA alone at the same total concentration (10 mg./ml.) IAA and 2, 4-D suppressed the development of the axillary bud. Such a feature was not noticed with IBA and NAA.

(iii) *Immersion of cuttings in water and salt solutions:*

It was found in general, that immersion of cuttings in water for a prolonged period (over 10 hours) was detrimental, but immersion in a 2% sucrose (cane sugar) solution showed a beneficial effect. A preliminary trial to determine the effect of treating the cuttings with different trace elements, by immersing them for 16 hours in dilute solutions of manganese sulphate and zinc sulphate, showed that treatment of cuttings with these trace elements inhibited root development.

(iv) *Breaking the dormancy of the axillary bud:*

(a) **Halving the mother leaf:** Halving the mother leaf of a rooted cutting, especially in clones with large leaves, induced the axillary bud to sprout quicker. Growth of the axillary shoot also appeared to be quicker and greater in the cuttings with halved mother leaf than in those with the uncut mother leaf. Complete removal of the mother leaf proved detrimental to the growth of the cutting.

(b) **Use of gibberellic acid and indolylacetic acid:** An experiment was carried out to determine whether treatment of rooted cuttings with gibberellic acid (GA) and IAA would induce quicker sprouting of the axillary bud and better growth of the axillary shoot. The treatments were as follows:

A. Untreated Control,

B. Mother leaf treated with 0.1 ml. of 50% alcohol,

C. Mother leaf treated with 0.1 ml. of 50% alcohol containing 4 micro-grams of IAA,

D. Mother leaf treated with 0.1 ml. of 50% alcohol containing 10 micro-grams of GA, and

E. Mother leaf treated with 0.1 ml. of 50% alcohol containing 4 micro-grams of IAA and 10 micro-grams of GA.

Each treatment consisted of five potted cuttings. The pots were kept under the shade of a high 'pandal' in the form of a 5 x 5 Latin Square for two months and later transferred to the open. The growth made by the axillary buds of the five cuttings two months after the treatment was determined. A second application of the treatments was given two months after the first and growth measurements were made again one and a half months after the second treatment. The results of this trial are given below:

Treatment.	Increase in length of 5 buds in mm.	
	2 months after first application	1½ months after second application
A	14	23
B	6	14
C	6	14
D	15	61
E	13	53
C.D. @ P: 0.05	7.5	18.1
@ P: 0 01	—	25.4

Bud length measurements two months after the first treatment did not reveal any beneficial effect of treatment with GA. However, after the second application, a significant difference in the growth of the treated and untreated buds was discerned. Treatment of the mother leaf with 50% alcohol and with IAA in 50% alcohol suppressed the growth of the axillary bud. It appears from this trial that treatment with even a very small quantity of 50% alcohol adversely affects the growth of the axillary bud It would be worth while carrying out a further trial with aqueous solutions of GA. This trial also confirms the previous observations on the depressing effect of IAA on bud development in tea cuttings [see Vegetative Propagation, section (ii)].

Growth Study:

(i) **Growth of Shoots:** Preliminary observations were made on the development of pluckable shoots during the periods May to July and July to September. During the period May to July, the bud in the axil of the mother leaf (i.e, the leaf above the 'fish' leaf left unplucked at the previous plucking) took 73.8 days on an average to develop into a pluckable shoot. The 'fish' leaf took 46.3 days (average) to develop from the time of the previous pluck, and each leaf thereafter unfolded about every 9 days. During the period July to September, the 'fish' leaf took on an average 48.8 days to form and each leaf thereafter unfolded every 11 days.

This would mean that a '2 leaves and a bud' shoot would be ready for plucking ordinarily on a 9 to 11-day plucking round and that if the plucking round should be further extended, the shoot would become coarse.

(ii) **Effect of the length of plucking rounds on yield of tea:** An experiment was planned to determine the effect of 7-day and 14 day plucking rounds on yield of tea bushes. A block of 26 clonal plants (blister blight resistant bush) of the same age were chosen for the trial. The bushes were pruned in April and tipped in June 1958. Thereafter they were plucked as usual, leaving one full leaf above the 'fish' leaf, until October 8, 1958. Based on the yield data obtained from these bushes, eight pairs of bushes of the same yielding capacity were selected. In each pair, one bush was plucked every 7 days and the other every 14 days. 'Flush' shoots and 'banjhi' shoots were both harvested and their number and fresh weight were recorded separately. The 'flush' shoots were classed under different categories, namely "2 leaves and a bud", "3 leaves and a bud" and "4 leaves and a bud" shoots. In the case of 'flush' other than "2 leaves and a bud", the weight was determined both before and after discarding the coarse leaf and stalk unfit for manufacture.

The data on the 'flush' shoots alone are presented here as plucking could be standardised with only such shoots. The results obtained during the period 14th October to 18th November 1958 are presented in the following tables:

Total number of 'flush' shoots from 8 bushes and fresh weight of shoots.

	7-day round	14-day round	% increase or decrease in longer round.
Total number of shoots. (2, 3 & 4 leaves and bud)	525	376	-28.3
Weight in grams. (including coarse leaf & stalk)	730.2	700.1	- 4.1
Weight in grams. (excluding coarse leaf & stalk)	635.3	486.9	-23.3

The longer round yielded decreased crop, both in number of shoots and yield as determined by fresh weight. Even including the coarse leaf and stalk, the total yield from the 14-day round was less than that from the 7-day round.

Number of "2 leaves and a bud" shoots and their weight from 8 bushes.

	7-day round	14-day round	% increase or decrease in the longer round.
Total number of shoots.	401	162	-59.6
Weight of shoots in grams.	484.0	209.6	-56.7

The number of '2 leaves and a bud' shoots obtained was greater in the 7-day plucking round than in the 14-day round. The yield of '2 leaves and a bud' shoots was correspondingly higher in the 7-day round than in the 14-day round. The yield of such quality shoots was less by 56.7% by weight in the 14-day round.

Number and weight of '3 leaves and a bud' shoots from 8 bushes.

	7-day round	14 day round	% increase or decrease in the longer round.
Total number of shoots	117	160	+36.7
Weight of shoots in grams including coarse leaf	226.7	345.5	+52.4
Weight of shoots in grams excluding coarse leaf	142.4	207.2	+45.5

The number of '3 leaves and a bud' shoots was greater, as expected, in the 14-day round than in the 7-day round and so was the total yield of shoots, but 40% of the leaf had to be discarded as coarse.

Number and weight of '4 leaves and a bud' shoots from 8 bushes.

	7-day round	14-day round	% increase or decrease in the longer round.
Total number of shoots	7	54	+671.4
Weight of shoots in grams including coarse leaf	18.5	147.0	+694.5
Weight of shoots in grams excluding coarse leaf	9.0	70.1	+678.8

The number of '4 leaves and a bud' shoots produced in the 7-day round was negligible. The number of shoots and yield of such shoots was higher in the 14-day round than in the 7-day round, but 52% of the yield had to be discarded as coarse leaf unfit for manufacture.

Summary of results (Observations based on 8 pairs of bushes)

	7-day rounds (6)	14-day rounds (3)
1. Total number of 'flush' shoots	525	376
2. Total weight of shoots (g.)	730.2	700.1
3. Weight of one shoot (g.)	1.39	1.86
4. Weight of shoots (g.) excluding coarse leaf & stalk	635.3	486.9
5. Weight of one shoot (g) excluding coarse leaf and stalk	1.20	1.29
6. Total number of '2 leaves and a bud' shoots	401	162
7. Weight of '2 leaves and a bud' shoots (g.)	484.0	209.6
8. Weight of one shoot (g)	1.20	1.28
9. Total number '3 leaves and a bud' shoots	117	160
10. Weight of '3 leaves and a bud' shoots (g.)	226.7	345.5
11. Weight of one shoot (g.)	1.94	2.16
12. Weight of shoots excluding coarse leaf (g.)	142.4	207.2
13. Weight of one shoot excluding coarse leaf (g.)	1.21	1.29
14. Total number of '4 leaves and a bud' shoots	7	54
15. Weight of '4 leaves and a bud' shoots (g.)	18.5	147.0
16. Weight of one shoot (g.)	2.71	2.72
17. Weight of shoots excluding coarse leaf	9.0	70.1
18. Weight of one shoot excluding coarse leaf (g.)	1.28	1.29

Even within a short period of study it was observed that longer plucking rounds do not necessarily give increased crops and that a shorter plucking round would give the maximum of quality shoots. It must be pointed out here that on an average a tea leaf unfolds every 8 to 11 days, mostly 9 days, under the conditions obtainable in Devarshola (the Nilgiri-Wynaad) and that a plucking round of about 9 days throughout the year in this tea growing district may be the optimum. These findings lend support to those of other workers elsewhere.

Weedkillers:

Trials with Dowpon (Dalapon) have shown that it is very promising in the control of annual and perennial grass weeds. On the basis of observations made during the year, we reckon that three applications of Dowpon, each at the rate of 5 lb. per acre in 80 to 100 gallons of water, may have to be made. In this district, the first application may be made in April or early May after some summer rains have been received and the grasses have started making fresh growth. The second application may be given one or two months after the first, when there is a break in the monsoon rains, and the third at the end of the main mansoon rains, say in November.

So far we have not noticed any visual phytotoxic symptoms on tea bushes in plots treated with Dowpon at the rates of 5 and 10 lb. per acre. An experiment has been laid out to determine whether yields are in any way affected by the treatment.

Dadap trees (*Erythrina lithosperma* Bl. ex Miq.) were adversely affected even with ground applications of Dowpon. A marked defoliation occurred in dadap trees in the plot treated with Dowpon at the rate of 10 lb. per acre. In the plots treated with Dowpon at the rate of 5 lb. per acre also, dadap trees defoliated, but they soon recovered putting forth fresh foliage. Recovery was, however, slow in the plot treated with 10 lb. of Dowpon. Young silver oak plants (*Grevillea robusta* A. Cunn.) did not show any symptoms of damage.

Grass weeds (*Cynodon dactylon* Pers., *Digitaria* sp., *Eleusine indica* Gaertn., *Eragrostis pilosa* Beauv., *Eragrostis tenuifolia* Hochst, *Eragrostis unioloides* Nees, *Panicum repens* L., *Paspalum conjugatum* Berg., *Paspalum scrobiculatum* L, *Setaria intermedia* R. & S., *Setaria pallidifusca* Stapf. & Hubb, and *Themeda triandra* Forsk) were all killed within a fortnight in both treatments (5 and 10 lb per acre), but in the case of the 5 lb. treatment, some fresh growth of grass was noticed a month and a half after treatment. Broad-leaf weeds were also initially affected, but within a month profuse growth of succulent weeds, was seen to get established in the treated plots. These weeds, however, were stunted and did not make their normal growth. In one of the trials the dominant species in the weed flora of the treated plots was *Borreria ocymoides* DC. In a second trial on a grassy patch, *Centella asiatica* Urb. was the most dominant species; it grew so quickly and profusely that no other weed had a chance to establish itself.

Maleic hydrazide (25% emulsion of triethanolamine solution) applied at the rate of 5 gallons per acre in 65 gallons of water and Malazide 40 applied at the rates of 10 and 20 lb. per acre in 65 gallons of water were ineffective in killing grass weeds with one application. Two applications, given at an interval of one month between applications, suppressed the growth of grass weeds in the plots treated with Maleic hydrazide emulsion and Malazide 40 at 20 lb. per acre. The weeds, however, were not killed.

It is realised that perennial grass weeds cannot be controlled by mechanical cultivation and weed control methods commonly in vogue. Dowpon appears very promising in the control of these weeds and it would be worth while, therefore, to study the economics of grass weed control in tea with this weedkiller.

Acknowledgements :

This is the last occasion on which the annual report of the Botanist will be issued by me and I would like to avail myself of this opportunity to express my sincere thanks to my colleagues and other members of the staff of the Tea Experiment Station for all the help which they have willingly and generously given me during the last eleven years. I would also like to add that assistance received from various other sources is greatly appreciated and gratefully acknowledged.

K. S. VENKATARAMANI,
Botanist.

REPORT OF THE PLANT PATHOLOGIST

(1958—1959)

General :

I was appointed to the post of Plant Pathologist in December 1957 and joined duty on April 2, 1958. The first three months were utilized in acquainting myself with the nature of work in my section and in this I was greatly assisted by the Botanist, Dr. K. S. Venkataramani, who had been handling all mycological work until my appointment. I gratefully acknowledge his kind help.

Advisory :

During this year 63 memoranda were sent out recommending control measures against various root, stem and leaf diseases. The majority of enquiries was on tea, followed by those on shade plants, coffee, rubber and other miscellaneous subjects. The total number of communications despatched was approximately 150.

Touring :

The following visits were made during the year :

May 1958	—	Terrace Estate, Nilgiris.
„	—	Venniar Estate, Highwavys Group, Madurai District.
September 1958	—	Mayfield Estate, Nilgiri-Wynaad.
November 1958	—	Daverashola Estate, Nilgiri-Wynaad.
December 1958	—	Kadamane Estate, Mysore State.
February 1959	—	Devon Estate, Nilgiri-Wynaad.
	—	Daverashola Estate, Nilgiri-Wynaad.
	—	Glenmorgan Estate, Nilgiris.
March 1959	—	Daverashola Estate, Nilgiri-Wynaad.

Publications :

The Plant Pathologist communicated the following articles to journals noted against each :

1. "A Simple plastic Bell Jar", Commonwealth Phytopathological News, 1959, (jointly with the Botanist).
2. "*Rhizoctonia solani* inciting collar rot of tea" *Phytopathology*, In Press (jointly with the Botanist).
3. "A New species of *Cylindrocladium* attacking tea plants" communicated to *Mycologia* (jointly with the Botanist).
4. "Results of Fungicide Tests for 1958", communicated to the American Phytopathological Society, (jointly with the Soil Chemist and the Botanist).

Research :

Root Diseases : Reports of root diseases in tea due to *Poria hypolateritia, Rosellinia arcuata, Ustulina zonata* and *Fomes noxius* were fairly common. In addition to these, one of the specimens sent from an estate in Madurai District was found attacked by *Armillaria mellea,* the fungus causing the 'root splitting disease'. This seems to be the second record of *A. mellea* on tea in Southern India, the first report having been made in 1934 from the Anamallais.

Another report of a disease in *Acacia decurrens,* coming from an estate in the Nilgiris, was identified as 'root splitting disease' caused by *Armillaria fuscipes Petch.* This is the first record of *A. fuscipes* in Southern India although this fungus has been reported from Ceylon on the same host.

Certain instances of disease in tea seedlings in the nursery were traced to fungal origin and the following organisms were established to have a definite role in inciting seedling diseases, at various stages of growth, in the nursery : *Cylindrocarpon* sp , *Cylindrocladium* spp., *Rhizoctonia solani, Phomopsis* sp., *Rhizoctonia bataticola* and *Botryodiplodia theobromae. Phomopsis* has been recorded on tea in Southern India for the first time.

Stem Diseases : 'Branch canker' caused by *Macrophoma theicola* and die-back of shoots due to *Leptothyrium theae* on tea in its first year after pruning were commonly reported. An interesting observation with regard to *Leptothyrium* 'die-back' was that the disease was not confined only to tea in the first year from pruning but that it could also occur in the second and even in the third year from pruning. The fungus is known to attack young tissue of the growing stem in the first year fields, travel back and ring the bark at the base causing a callus formation which can often be seen encircling the base of the stem. It is possible that the fungal infection remains latent in some cases, under certain conditions, but later when conditions favour disease development it causes typical 'die-back'. In estates which have past records of *Leptothyrium* 'die-back' and *Macrophoma* 'stem canker', it is recommended that the tea bushes be given three fortnightly rounds of fungicide spray soon after pruning, as a preventive measure. Either 1% Bordeaux mixture or any of the 50% copper fungicides (proprietary products), 3 lb. dispersed in 40 gallons of water, may be employed at the rate of 40 gallons to the acre.

Several instances wherein considerable damage to young tea shoots had been caused by the 'grey blight' disease came to light in 1958. In addition to the common *Pestalotia theae,* a species of *Pestalotiopsis* was isolated from one of the specimens. This fungus is being studied for its distinguishing morphological characters and its pathogenicity on tea. *Pestalotia theae* was also found infecting the bark in internodal cuttings of tea which had failed to strike root in the nursery. When healthy cuttings were artificially inoculated with the fungus it was observed that

the organism caused numerous necrotic lesions on the bark and finally killed the cuttings. It is believed that the fungus is carried on the cuttings taken from infected 'mother bush', the infection in certain cases being a minute spot which could easily escape detection. It seems obvious that the damage to shoots and cuttings caused by *Pestalotia theae* could become serious under certain conditions.

Rhizoctonia solani was isolated from diseased 2 – 3 year old tea plants in a new clearing on an estate wherein it had caused widespread damage. The fungus had caused typical 'collar rot', a thick growth of callus tissue having been invariably produced by the plant around the site of infection. Deep planting (planting above the nursery level) and injudicious mulching were found responsible for predisposing the plant to fungal attack. Pathogenicity trials carried out here have confirmed that *R. solani* is a potential parasite on tea and that it can cause (i) root rot in young seedlings in the nursery and (ii) collar rot in 2 - 3 year old plants in the field. The fungus, however, seemed incapable of attacking healthy stem but incited collar rot only when the tissue was injured or otherwise rendered susceptible as in the case of plants which are deep planted. In the latter the portion of stem covered with the soil becomes soft due to physiogenic factors.

Stem infection in shade plants was reported from various estates It was observed that the practice of tying shade plants to a stake to prevent lodging in strong winds was, in several cases, responsible for the occurrence of stem cankers. It was found that the material (string) employed for tying plants had cut into the plant tissue by continuous rubbing, the wound thus formed on the stem giving access to entry by certain fungal organisms which are incapable of attacking sound tissue. Infection had subseqnently developed during favourable environmental conditions and the plants had died back. In the older plants several cankers were observed, each formed in succession at a point at which it was tied to a stake during one season. It has been recommended that where tying plants to a stake is essential a pad of moss be placed in between the string and the stem to avoid injury to the stem tissue.

Leaf Diseases: Apart from blister blight, only a few instances of leaf diseases, namely 'brown blight' and 'grey blight', were reported. Blister blight, however, was very severe both during the South-West as well as the Nort-East monsoon periods and infection of shoots in bushes which had not been given any protective spraying often exceeded 90%. Weather conditions between June and December 1958 were favourable for blister blight infection.

Blister Blight Trials

1. Field trials were laid out for screening various fungicides which were received from several sources for their efficiency in controlling the disease. Nine different formulations were tested and the results of these trials are given in the Appendix.

2. In addition to the fungicide screening experiment, a plot-trial was laid out to investigate the possibility of increasing the interval between spraying rounds, whilst achieving adequate control of blister blight infection. Two standard 50% copper fungicides were used in this trial and details of the results obtained are given in the Appendix.

3. A small plot-trial was also carried out wherein individual bushes were sprayed with water at definite intervals following application of fungicide spray, to determine the extent to which the fungicide remaining on the foliage was effective in checking blister blight. Results are given in the Appendix.

Blister Blight Forecasting: The usefulness of a system for forecasting blister blight epiphytotics is too obvious to need any emphasis here. Certain workers in Indonesia found that an inverse relationship existed between the hours of morning sunshine and blister blight incidence. In many tea growing areas of Southern India there is hardly any sunshine, at any time of the day, during the South-West monsoon period and, therefore, this factor is unimportant in influencing blister blight infection. It is also not conceivable that fluctuations in rainfall, humidity and temperature could be responsible for the high or low incidence of blister blight, because these meteorological factors are throughout favourable for the disease. It would, then, seem that severity of blister blight infection could vary due to changes in spore liberation, its concentration in the air and its success of infection. An attempt was therefore, made to study the dispersal of blister blight spores and it was observed that by interpreting records of spore concentration, humidity and rainfall the approximate severity of infection could be estimated. These investigations will be continued in the 1959 blister blight season and the results will be reported in due coure.

Eradication of Root Diseases: One of the problems in the control of Root Disease fungi is to eradicate the fungal inoculum from soils when the plant is killed in the field by the disease. Digging out and removing every bit of the infected root system of the diseased plant is tedious and may not always be thorough. It was deemed worth while to investigate whether certain chemical fumigants when injected into the soil could kill these fungi colonized within host tissue. Experiments were carried out with CBP. 55, Shell-DD, Nemagon, Formalin, Captan, Copper oxide and Vapam and their effect on the survival of *Fomes noxius*, *Rosellinia arcuata* and *Ustulina zonata* was studied under field and laboratory conditions. These investigations are being continued, but preliminary findings indicate that Vapam, CBP. 55, Shell-DD and Formalin, in the order mentioned, can effectively kill the three fungal organisms resident in the host root in soil.

Systematic Mycology; The following are new records of fungi isolated from tea and shade plants in Southern India:

1. *Phomopsis* sp —parasitic on tea roots.
2. *Rhizoctonia solani*— parasitic on tea roots.
3. *Pestalotiopsis* sp. —parasitic on tea shoots.
4. *Armillaria fuscipes* Petch—parasitic on roots of *Acacia decurrens*.

The following is a new record for India:

Ciliospora gelatinosa Zimmerman—isolated from diseased tea leaves.

Coffee:

Several diseased specimens of coffee seedlings were received for examination and were found to have been infected with *Fusarium bulbigenum*. Specimens of another disease, commonly referred to as "KUNDALI" disease, were also received and on culturing the diseased tissue of affected coffee seedlings, two fungi, species of *Chaetophoma* and *Phoma*, were consistently isolated from all specimens.

Rubber:

Specimens of diseased rubber, approximately one year old, were received for investigation from an estate in Kerala. The affected plants manifested symptoms of leaf chlorosis and had root system with numerous necrotic areas. *Botryodiplodia theobromae, Rhizoctonia bataticola, Phomopsis* sp. and *Fusarium* sp., were isolated from the diseased roots.

Cardamom:

Specimens of diseased rhizomes of cardamom plants were received from an estate in the Nelliampathies. The occurrence of numerous necrotic spots was observed on all specimens and isolation of microorganisms from the diseased tissue resulted in the detection of a species of *Cylindrocarpon* which was probably the causal agent.

Acknowledgements:

I am thankful to the Commonwealth Mycological Institute, Kew, for the identification of fungal cultures and to the managements of several estates which I visited in 1958-59 for their help and hospitality. Help received from the Soil Chemist and the Botanist in carrying out the blister blight trials is gratefully acknowledged. Thanks are also due to various firms which have generously sent us samples of several chemicals for tests.

C. S. Venkata Ram,
Plant Pathologist.

APPENDIX

CONTROL OF BLISTER BLIGHT OF TEA IN SOUTHERN INDIA—THE 1958 FIELD TRIALS

BY

V. Jayaraman and C. S. Venkata Ram

In the past decade, year after year new and old formulations of several fungicides have been tested in Southern India against blister blight disease of tea plants (1, 2, 3, 4). The aim of these field trials has been to assess (i) the qualities of the fungicide formulations in protecting the plants against the disease and (ii) their efficiency under varying weather conditions. The results of our investigation in the 1958 blister blight trials are presented in this paper.

MATERIALS AND METHODS

In all, nine different fungicide formulations were tested, the details of which are given in Table I.

TABLE 1. Fungicides tested, their composition and source.

	Fungicide.	Composition.	Source.
1.	Bayer 4848	50% metallic copper content as oil bound oxychloride	M/s. Chika (P) Ltd., Bombay.
2.	Blitox '50'	50% copper, oxychloride	M/s. Tata-Fison (P) Limited, Bangalore-1.
3.	Cobredon	45% copper, carbonate	M/s. Jan de Poorter (Chemie) N. V. Rotterdam.
4.	Colloidal copper	21% metallic copper in colloidal form	M/s. Mysore Insecticides, Madras.
5.	Coppesan	45% copper, oxychloride	M/s. Boots Pure Drug Co., (P) Ltd., Bombay.
6.	Experimental Fungicide 7	25% copper, oxychloride	M/s. Tata-Fison Private Ltd., Bangalore-1.
7.	Microcop	50% copper, oxychloride	M/s. Sudhir Chemical Co., Bombay-3.
8.	Omicron '24'	24% coated copper, oxychloride	M/s. Fisons Pest Control, U- K.
9.	Perenox	50% copper, oxide	M/s. I. C. I. (I) Private Ltd., Madras-1.

It was not feasible to test all the nine fungicides in a single trial and, therefore, for the sake of convenience three experiments were carried out and all of them were laid in the Tea Experiment Station.

The fungicides were sprayed with pressure retaining knapsack sprayers employing a low-volume (Γ-jet) nozzle at the rate of approximately 15 gallons of the spray fluid, containing different concentrations of the fungicide in each treatment (Table 1), to the acre. Spraying was carried out on 7-day rounds on the day following plucking. Severity of blister blight infection was estimated by examining individual shoots in two random samples, each of 100 shoots, taken from a lot comprising the total number of pluckable shoots in each replicate of treatment. Figures for disease incidence are given as percentage shoots manifesting blister blight infection and represent the mean of four replicates in one treatment. Although scores were given for severity of infection in individual shoots, these results are not being included here because they do not bear any special significance.

Experiment I was laid out in a field 13 months from pruning, started on May 31st and continued till November 22nd. In addition to the check (control unsprayed), ten fungicide treatments were included in this experiment, each treatment comprising four replicates each of a row of 12 bushes, randomised, with a guard row of untreated bushes left between two treated rows.

Experiment II was made from June 5th to September 11th in a field due for pruning in 1959. Six fungicidal treatments were included in this, a treatment consisting of four replicated plots each of two adjacent rows of five bushes with a guard (unprotected) row in between two treated plots.

The third trial, Experiment III, was started on October 10th and carried out during the North-East monsoon period. This experiment was laid out in a tea field pruned in April 1958 and comprised three treatments, in quadruplicate, there being a row of 12 bushes in each replicate, and the treatment rows being separated by guard rows.

RESULTS.

The data on the efficiency of fungicides at selected periods of sampling are given in Tables 2, 3 and 4.

Experiment I: It is seen (Table 2) that the two formulations containing 50% copper, either as oxide (Perenox) or oxychloride (Blitox '50'), throughout gave satisfactory results when used at the rate of 6 oz. per acre. However, at half this strength (3 oz.), only Perenox, but not Blitox '50', gave adequate protection.

Results obtained in the past (1, 2, 3, 4) have indicated that a good formulation of 50% copper oxide, viz., Perenox or Copper Sandoz, gives very satisfactory protection against the disease. Hence, the figures for disease incidence obtained in treatments 6 to 11 (Table 2) have been compared with those obtained in the case of Perenox at 6 oz. which has been taken as the standard.

Experimental Fungicide 7 and Omicron '24' are new formulations, the former containing 25% copper and the latter 24% as oxychloride. It was observed that Omicron '24' at 12 oz /acre gave satisfactory protection throughout and there was no significant difference between the control achieved in this and in the standard fungicide treatment, which represents comparable levels of copper used in the two treatments.

At half the amount of copper per acre, i.e., equivalent of 3 oz. of fungicide containing 50% copper, Experimental Fungicide 7 and Omicorn '24' gave significantly better disease control than Blitox '50' but less than that achieved with Perenox. Only Omicron '24' was tested at one-fourth the level of copper normally applied (6 oz. of 50% copper formulation) and at this concentration it failed to give adequate protection.

The question was considered whether the application of spray containing low concentrations of copper would be more effective if a sticker were to be added to it. In treatments 8 and 10 (Table 2), Tenac, a sticker supplied by Messrs. Burmah-Shell, was incorporated in the spray fluid at the rate of one-third the weight of the fungicide used. However, the addition of Tenac did not improve the performance of the fungicide at the two concentrations tried. Experiments in Ceylon (5) have also shown that the addition of Tenac to Shell-Copper did not have much effect in comparison with other 50% fungicides without a sticker and at the same rate.

Experiment II: Results of this trial are presented in Table 3. It was indicated that formulations of copper oxychloride containing 45% (Coppesan) and 50% (Microcop and Bayer 4848) copper gave disease control comparable to that achieved with the standard fungicide (Perenox).

Colloidal (21%) copper gave protection comparable to that of standard fungicide at equal rates of fungicide application, namely, 6 oz. to the acre. At this rate the amount of copper applied as colloidal copper is approximately two-fifth that of the standard fungicide.

In Experiment III, the results of which are given in Table 4, only one formulation, namely Cobredon, was tested in comparison with the standard fungicide (Perenox). It is seen that the 45% copper carbonate formulation (Cobredon) throughout gave statistically the same control as the standard fungicide when both were applied at the rate of 6 oz. to the acre.

DISCUSSION.

In conformity with past observations (1, 2, 3, 4) this year's field trials have shown that at 6 oz. rate of application, fungicides based on 50% copper formulation, either as oxide or oxychloride, four of which were tested here (Perenox, Blitox '50', Microcop and Bayer 4848), give a high measure of protection which normally ranged from 60 to 90 per cent disease control. Again, at 6 oz. per acre application, the

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TABLE 2

Giving the results of Fungicide Trial in Experiment I.

Treatments and rate per acre.	Percentage Shoots infected										
	July 4	July 11	July 18	July 25	Aug. 8	Aug. 14	Sept. 1	Sept. 12	Sept. 19	Oct. 3	Oct. 24
1. Control (Untreated)	82.6	57.4	87.4	67.9	58.8	60.0	79.6	76.0	75.5	67.0	71.0
2. Perenox (6 oz.)	*21.0*	*11.3*	*27.6*	*20.5*	*8.6*	*9.1*	*27.0*	*29.9*	*16.7*	*15.0*	*18.0*
3. Blitox '50' (6 oz.)	*22.4*	*8.6*	*30.5*	*17.9*	*4.9*	*11.3*	*31.8*	*25.5*	*13.7*	*17.0*	*15.0*
4. Perenox (3 oz)	*24.5*	*18.9*	*36.3*	32.6	*14.8*	*13.4*	*34.4*	*32.4*	*21.9*	*18.0*	*26.0*
5. Blitox '50' (3 oz)	*32.8*	21.1	47.1	*28.6*	*18.1*	19.5	47.6	47.4	41.7	36.0	37.0
6. Experimental Fungicide 7. (6 oz.)	34.5	*19.4*	*40.9*	34.0	*12.0*	*12.5*	*36.3*	*32.9*	*31.7*	*25.0*	33.0
7. Omicron '24' (3 oz.)	42.3	29.9	50.0	34.6	*16.9*	25.0	43.3	*41.4*	36.1	38.0	34.0
8. Omicron '24' + Tenac (3 oz.)	39.5	*18.1*	49.8	34.6	22.5	20.9	47.6	*46.6*	40.7	50.0	36.0
9. Omicron '24' (6 oz.)	41.3	*18.9*	44.6	*27.6*	*16.0*	21.4	39.1	*36.8*	*26.0*	*21.0*	*23.0*
10. Omicron '24' + Tenac (6 oz.)	36.6	*18.5*	*37.0*	*28.5*	*16.9*	*16.5*	42.5	*42.6*	37.4	42.0	33.0
11. Omicron '24' (12 oz.)	*24.5*	*14.3*	*27.9*	*20.8*	*11.0*	*12.6*	*31.9*	*36.5*	*27.5*	*23.0*	*24.0*
Difference required for significance (P = 0.05)	12.2	9.2	14.2	11.9	9.5	9.6	11.5	16.8	15.2	14 0	13.5

TABLE 3

Giving the results of Fungicide Trial in Experiment II.

Treatments and rate per acre.	Percentage shoots infected.				
	July 2	July 16	July 23	Sept. 3	Sept. 10
1. Control (untreated)	57.4	67.8	62.0	67.0	75.6
2. Bayer 4848 (6 oz.)	9.8	4.8	6.3	14.6	11.9
3. Colloidal copper (6 oz.)	13.5	11.5	7.5	13.4	16.5
4. Perenox (6 oz.)	12.0	9.1	7.1	13.9	14.0
5. Microcop (6 oz.)	16.5	8.4	9.0	15.1	12.5
6 Coppesan (6 oz)	12.4	11.8	9.0	15.9	15.5
Diff. required for significance (P=0.05)	9.6	5.7	8.3	9.7	9.7

TABLE 4

Giving the results of Fungicide Trial in Experiment III.

Treatment and rate per acre.	Percentage shoots infected.				
	Nov. 17	Nov. 24	Dec. 1	Dec. 8	Dec. 15
1. Perenox (6 oz.)	31.0	49.0	55.0	31.0	32.0
2. Cobredon (6 oz.)	17.0	38.0	46.0	33.0	37.0
3. Control (unsprayed)	62.0	84.0	96.0	87.0	75.0
Difference required for significance (P=0.05)	18.1	15.0	11.0	11.7	16.3

THE RELATION OF INTERVAL BETWEEN FUNGICIDE APPLICATION TO THE CONTROL OF BLISTER BLIGHT DISEASE OF TEA PLANTS.

BY

C. S. Venkata Ram and V. Jayaraman

Investigations carried out by Haworth (1) have shown the extent to which copper fungicides are retained on the tea leaf under conditions of varying rainfall. It was observed that when the fungicide spray had once dried on the leaf surface it resisted the washing action of moderately heavy rain. It was also observed that comparatively small amounts of rain washed off the bulk of the fungicide on leaves exposed before the spray had dried, but that the remainder was held under subsequent prolonged washing. From these and other results Haworth (1) concluded "it seems as if small amount of copper fungicide retained under bad weather conditions is sufficient to give a *measure* of protection against blister blight infection". In 1949 it was observed in North-East India (2) and in Ceylon (3) that spraying with Perenox at fortnightly intervals gave excellent protection against blister blight disease. Evidently, the prophylactic effect of Perenox lasted for 15 days and indeed, its efficiency in reducing disease incidence was almost as good at fortnightly applications as in weekly spraying (3). However, in 1950, application at fortnightly intervals was not found to be as effective as weekly spraying in the Ceylon trials (3), contrary to the results obtained in 1949 and this was attributed to greater severity of blister blight infection in 1950 than in 1949.

In our programme of blister blight control, one of the aims is to reduce the cost of protection. It is recognised that in the tea shoots growing for a unit time, the amount of additional plant tissue growth made during this time will be susceptible to fungal invasion. As shown by Tubbs (4) the area of newly exposed leaf tissue increases by approximately 13 times at the end of one week and by 87 times at the end of a fortnight in the actively growing shoot; thus the ratio of opportunity (of infection) in the first week to that in the second week is roughly 1 : 6. Nonetheless, although spraying with copper fungicides at 7- (5) and 10-day (6, 7) intervals has consistently given satisfactory protection against the disease, in certain trials even fortnightly application of a good formulation has given adequate protection (2, 3). Obviously, under certain environmental conditions a schedule of fortnightly spraying could give satisfactory protection. Clearly, then, there is a case for further field trials to test the efficiency of fungicides at increased interval between applications as compared to the normal 7-day spraying rounds. The results of such an investigation are presented in this paper.

MATERIALS AND METHODS.

The trial was laid out in the Experiment Station in a tea field due for pruning in 1959. Perenox (50% copper, oxide) and Blitox '50' (50% copper, oxychloride) were the fungicides tested at applications of 6 oz. per acre on 7-, 10-and 14-day rounds. All treatments consisted of four replicated plots, each of two adjacent rows of five bushes each with a row of untreated bushes between two treated plots. Spraying was carried out at the rate of approximately 15 gallons to the acre with pressure retaining knapsack sprayers fitted with a low volume (T-jet) nozzle. The treated bushes were plucked on weekly rounds, shoots in each plot bulked and a random sample of 100 taken in which individual shoots were examined for blister blight infection. The average of infection in four replicates is given as percentage shoots carrying blister blight in a treatment.

RESULTS.

The experiment was started on October 10th and continued till December 23rd. As can be seen from Fig. 1, blister blight infection in the untreated plots (control) was severe during the period of this trial and in three samplings over 90% of the unprotected shoots were found attacked. Blister blight infection during the months of November and December 1958 was the worst on record in this Station.

Protection achieved with 7-day round application of fungicide was statistically the same throughout in both the 50% copper oxide (Perenox) and oxychloride (Blitox '50') treatments. However, excepting on two occasions, the percentage of infected shoots in the two treatments was over 30 in all samplings and twice exceeded 50% (Fig. 1 C and D). Such a high incidence of blister blight in tea plants treated to 7-day rounds of fungicide spraying with standard 50% copper formulations does not lend itself to any reasonable explanation other than that when the severity of infection is very great even standard fungicide treatments give comparatively small protection.

Fungicide spraying on 10-day rounds, either Perenox or Blitox '50', gave control of infection which in five out of six samplings, was not statistically different from that achieved in the standard fungicide treatment (7-day round spraying of Perenox). Observations on disease incidence made on December 17th (Fig. 1 F) revealed that, although protection achieved with 10-day round spraying of Blitox '50' and Perenox was statistically less than in the standard fungicide treatment, it was yet satisfactory as compared to disease control obtained on other occasions (Fig. 1 A & E) in these treatments. In the December 17th sampling, figures for blister blight infection were lowest in the 7-day round treatment compared to others; it is, therefore, indicative that when protection achieved in the 7-day round application decreases considerably, the 7 and 10-day intervals between application tend to give statistically the same disease control.

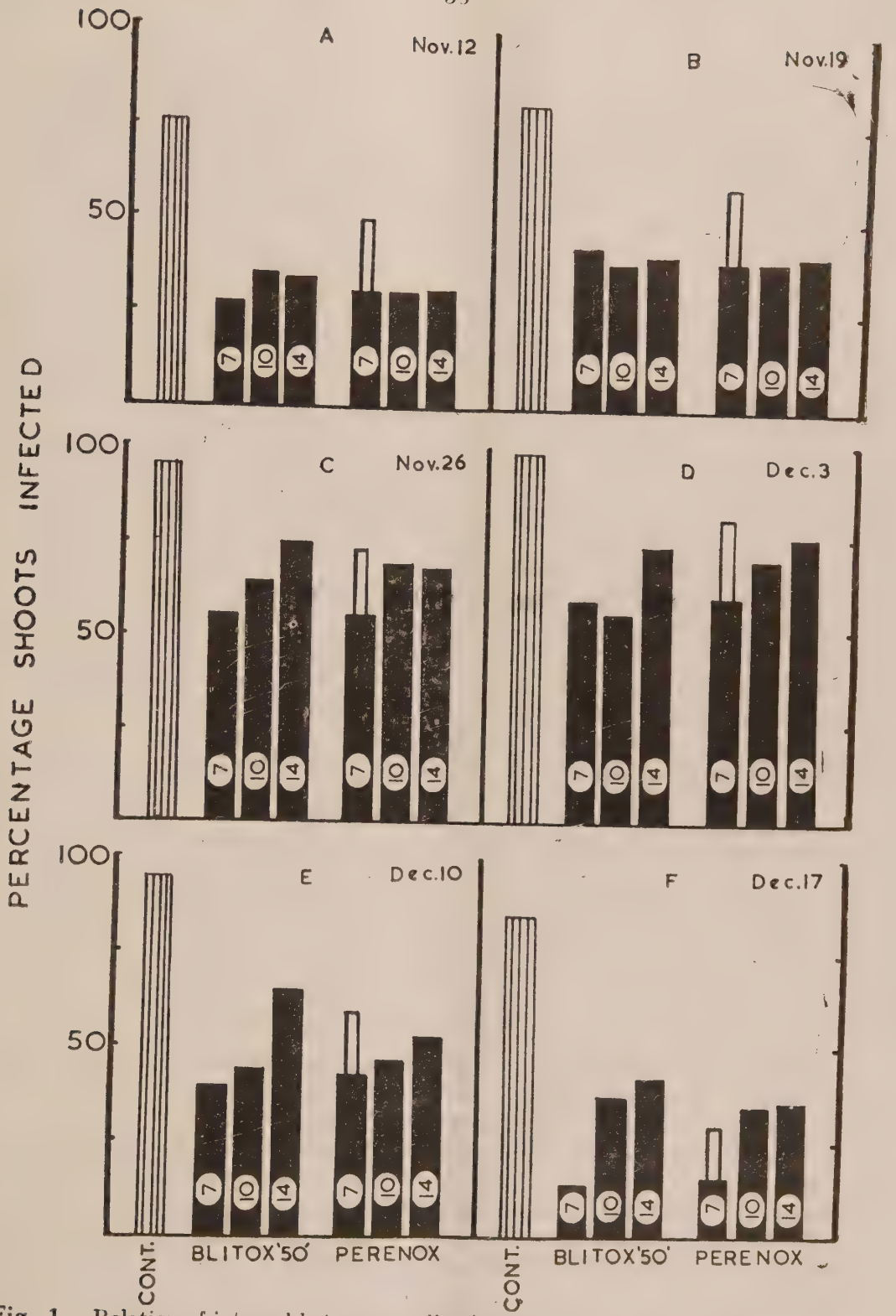

Fig. 1. Relation of interval between applications of Blitox '50' and Perenox on blister blight infection. Figures in the filled histograms indicate interval in days between two applications of the fungicide. The emply block on the filled histograms refers to diffierence required for statistical significance between treatments, P=0.05.

In the 14-day round application of fungicides, Perenox gave protection comparable to that obtained with the standard fungicide treatment inasmuch as blister blight infection in the two treatments was not statistically different in five out of the six samplings. On the other hand, Blitox '50' gave protection which was statistically lower than in the standard fungicide treatment in three out of the six occasions. Application of Perenox on 14-day rounds was comparable to the 10-day round treatment in affording protection, whereas 14-day round treatment with Blitox '50' was inferior to the 10-day round application of this fungicide.

DISCUSSION.

Perenox and Blitox '50' were sprayed at 7, 10 and 14-day intervals and their efficiency in reducing blister blight infection of tea was estimated. During the course of the trial disease incidence was very high in the unprotected (control) plots and abnormally high even in the fungicide treated ones. Spraying with the two fungicides at 6 oz. to the acre on 7-day rounds gave protection which ranged from 37 to 80 per cent in Perenox and 40 to 83 per cent in the case of Blitox '50'. Disease control achieved with the standard fungicide treatment, i.e., 7-day round application of Perenox, in the six weekly samplings was 61, 51, 43, 37, 55 and 80 per cent, whilst the figures obtained in the corresponding treatment with Blitox '50' were 64, 47, 42, 40, 58 and 84 per cent, The plausible explanation to account for this comparatively poor protection afforded against blister blight by 7-day round spraying with good 50% copper fungicides seems to be that in the duration of the present experiment blister blight infection was very severe. It, then, follows that the efficiency of these fungicides decreases markedly under high severity of infection.

Application of Perenox and Blitox '50' on 10-day rounds gave protection which was statistically the same as in the standard fungicide treatment in five out of the six weekly counts. The only time when disease control in the 10-day round application of the fungicide was statistically less than in the standard treatment was when a high percentage protection was achieved in the standard treatment. It appeared, therefore, that when blister blight infection was comparatively high in Perenox treatment at 7-day intervals, disease control achieved in this did not differ statistically from that in the 10-day round treatment.

Perenox sprayed at 14–day intervals, but not Blitox '50', gave protection which ran parallel to that achieved in the 10-day round application of the fungicide. Perenox, then, when applied at 10– or 14-day intervals gave protection comparable to the standard treatment. These results are in agreement with previous findings on the efficacy of this fungicide in controlling blister blight disease when applied at 10–day (6, 7) and 15-day (2, 3) intervals. Further support to these findings comes from observations made by one of the authors (8) that when Perenox is sprayed on tea shoots, the fungicide retained on the leaf surface for over 15-days, under conditions of varying severity affecting retention, inhibits spore

germination to an extent comparable with inhibition obtained 3, 5, 7 and 10 days after application of the fungicide. The fungicidal powers of residues of cuprous oxide sprayed on potato foliage have been shown to be superior to that of Bordeaux mixture (9), an observation which fits in with the performance of Perenox (cuprous oxide) noted here.

It is not intended that the results obtained here provide conclusive proof of the efficiency of Perenox spray in checking blister blight infection when applied at 10- and 14- day intervals. But it is purported to show that under certain environmental conditions a time interval of 14- days between two fungicide applications will not give significantly different results in blister blight control from those obtained with applications at 7- or 10- day intervals. Further field trials carried out under varying meteorological factors are warranted before a 14- day round schedule of fungicide treatment can be recommended to the grower. Also, the observations made in the present trial refer only to tea plants in bearing and may not be applicable to bushes recovering from pruning; the trial was undertaken in the North-East monsoon period and it is intended to carry out the trial in South-West monsoon period this year. However, if for any unavoidable reason, one is obliged to increase the interval between spraying rounds to 10- or 14- days, the position may not be an unhappy one, judged from the results presented here which show that a good cuprous oxide can be statistically as effective at 14- day as at 7- day interval in giving protection against blister blight.

Another point emanating from these trials is that, during peak periods of infection, although the differences between the levels of infection in the 7-, 10- and 14- day rounds are not statistically significant, yet these differences are of the order of 11 to 17% more than in the 7- day treatment. To what extent these differences affect yield and vigour of the bush and whether they offset the economic and practical advantages gained in the longer spraying rounds are points which need further investigation.

SUMMARY.

1. Investigations were carried out on the relative effects of 7-, 10- and 14- day spraying rounds with Perenox (50% cuprous oxide) and Blitox '50' (50% copper oxychloride) at 6 oz. per acre on blister blight disease of tea plants.

2. During high severity of infection, spraying even at 7- day intervals gave only low protection.

3. Application of both the fungicides at 10- day intervals gave statistically the same protection as when applied at 7- day intervals, almost throughout the experiment.

4. Perenox applied at 14- day intervals gave results which ran parallel to those achieved with 10- day round application of the fungicide and were comparable to the protection given by the standard fungicide treatment (7- day round application of Perenox). On the other hand, Blitox '50' sprayed at 14- day intervals gave significantly less protection than the standard treatment.

5. It was indicated that when severity of blister blight infection was high, spraying with Perenox at 7-, 10- and 14- day intervals and with Blitox '50' at 7- and 10- day intervals did not give statistically different results.

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THE RELATION OF INTERVAL BETWEEN FUNGICIDE SPRAYING ON TEA LEAVES AND SUBSEQUENT WASHING BY SIMULATED RAIN TO BLISTER BLIGHT INFECTION

BY

C. S. Venkata Ram

Haworth (1) observed that when a copper fungicide spray, applied to tea plants, had once dried on the leaf surface it resisted the washing action of moderately heavy rain. It was also noted by him that comparatively small amounts of rain washed off the bulk of the fungicide on leaves exposed before the spray had dried, but the remainder was held under subsequent prolonged washing. When Perenox (50% copper oxide) was sprayed and dried on tea shoots, the fungicide retained on the leaf surface, after washing by simulated rain for 10 minutes every day for 15 days, had not lost its efficiency in inhibiting spore germination (2).

While it is a recognised fact that the usual crop protection practice is to apply fungicide spray under dry conditions, it very often becomes necessary to carry out spraying against blister blight disease of tea plants in Southern India (caused by *Exobasidium vexans* Masee) under wet and adverse weather conditions which normally prevail during the South-West monsoon months. Often, spraying operations are started when there is no rain, but a sudden shower is experienced either simultaneously with, or a few minutes after, the application of the fungicide to the plant. Under these conditions, what is the protection likely to accrue out of the fungicide treatment? What measure of protection will the commonly employed copper fungicides give against the disease when application is soon followed by rain? Will the results obtained in the laboratory, namely that a 50% copper oxide sprayed on tea shoots and subsequently washed by simulated rain effectively inhibited spore germination up to 15 days (2), be applicable under field conditions? A plot trial was carried out in the field to provide answers to these questions and the results obtained are presented in this paper.

MATERIALS AND METHODS

The experiment was laid in a pruned field in the Tea Experiment Station and was carried out between September 26 and December 15, 1958. Small plots of 6 tea bushes, 2 rows each having 3 plants, were marked and 24 such plots, 6 each in 4 plocks, were taken for the trial. In all, there were 6 treatments and each was replicated 4 times and randomized in the 4 blocks. The plants were sprayed on weekly rounds on the day following plucking. All pluckable shoots obtained from a single plot were examined individually for blister blight attack and the results are given as percentage infection and represent the mean of four replicate plots in each treatment.

The various treatments were: (1) control, not sprayed with the fungicide, (2) sprayed with fungicide (Blitox '50' at a concentration of 4 oz. in 10 gallons of water), (3) sprayed with the fungicide and immediately washed with a spray of water, (4) sprayed with the fungicide and washed with water after an interval of 2–3 minutes, (5) sprayed and washed after an interval of 7–8 minutes and (6) sprayed with the fungicide and washed 15–16 minutes later.

In all cases the fungicide was applied by pressure retaining knapsack sprayers fitted with a low-volume (T-jet) nozzle at the rate of approximately 15 gallons per acre. Washing with a spray of water was achieved with the same type of sprayer employing a coarse nozzle which discharged at the rate of approximately half-a-gallon of water in one minute. In a single plot, each of the six bushes was sprayed with water for 30 seconds which was equivalent to 10 cents of rain falling thereon. It was necessary to carry out the spraying in the forenoon when the rate of evaporation was high and good drying of spray deposit on the leaf could be achieved; this was accomplished, fortuitously, throughout in bright and sunny weather,

DISCUSSION OF RESULTS

Data presented in Fig. 2 shows that spraying with the copper fungicide reduces blister blight infection significantly, even when the sprayed plants are immediately subjected to the washing action of the simulated rain. Statistically the same protection was obtained whether washing of the fungicide was carried out immediately or 2–3 minutes after application. However, when the interval between fungicide application and washing was 7–8 minutes, disease control achieved was significantly greater than when the interval was 2–3 minutes. Increasing the time interval to 15–16 minutes or no wash did not result in further significant increase in disease control. Thus, protection given by the fungicide whether washed 7–8 or 15–16 minutes after application or left unwashed, was statistically the same.

From these results it is clear that, under the conditions of the present trial, an intervel of 7 minutes between fungicide application and washing by simulated rain seemed to be the critical limit for obtaining optimum disease control and increasing the interval beyond this period did not result in any significant additional increase in protection achieved. Logically, approximately 7 minutes were required for the fungicide spray to dry completely on the leaf surface. This time, however, will vary, depending on the environmental factors, and during the typical monsoonal weather it is likely to be much more than 7 minutes and on occasions when there is continuous rain the fungicide may not dry at all. Nevertheless, it is interesting to note that even when the plants were subjected to the washing action of simulated rain immediately after the application of the fungicide, a significant reduction in disease incidence resulted.

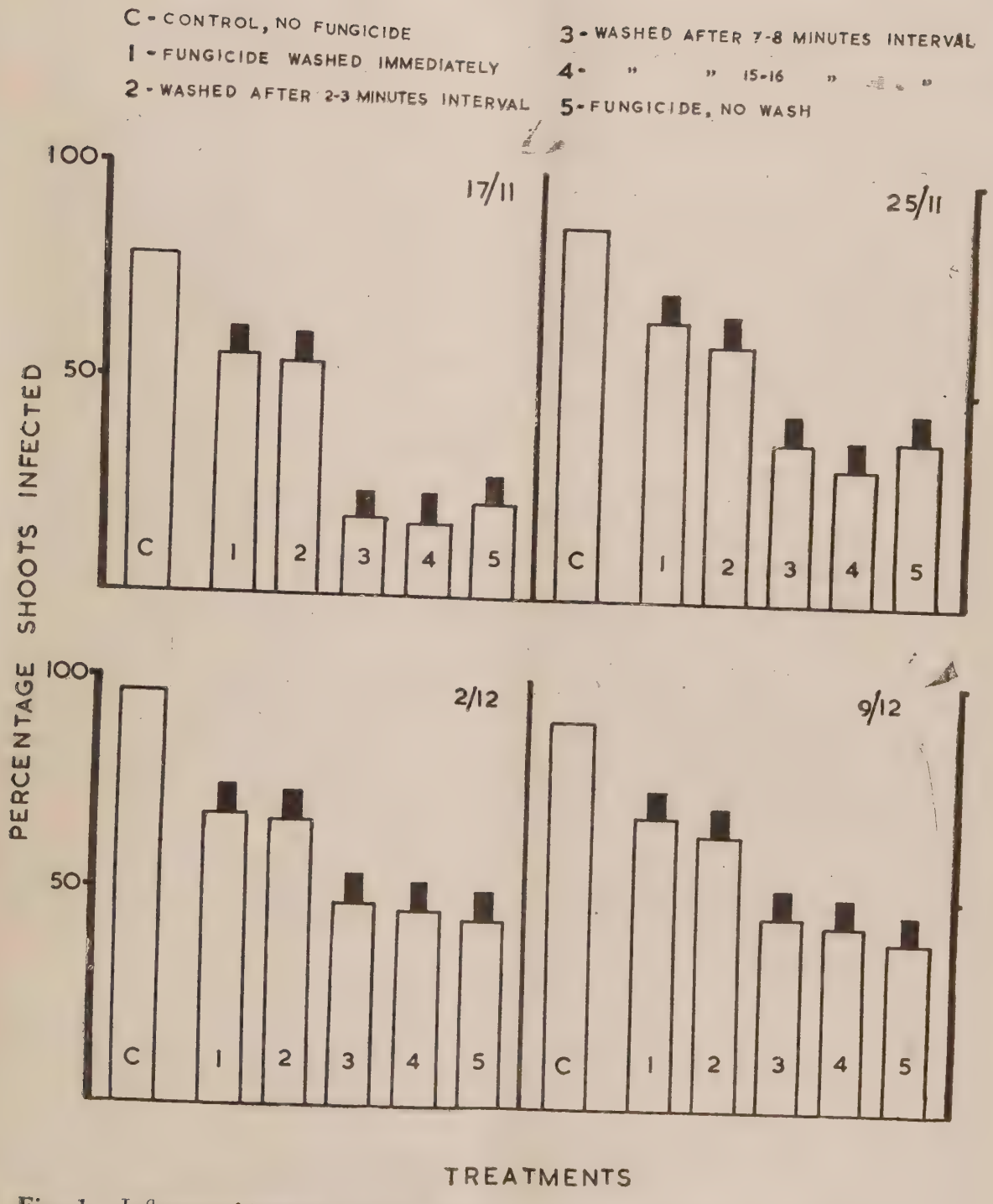

Fig. 1. Influence of interval between fungicide sprayings on tea leaves and subsequent washing by simulated rain on blister blight infection. Small filled blocks on the histograms indicate difference required for statistical significance between treatments, P=0.5.

In the present experiment the washing action of the water sprayed on individual plants was the equivalent of 0.10 inch of rain falling thereon. A heavier fall of the simulated rain would have probably resulted in lesser protection than what was obtained in treatments wherein the fungicide spray was followed, at various intervals, by a wash. Further work on these lines, which will be undertaken shortly, will provide information on this point. However, it must be remembered that all the plants weathered rain which fell to varying extent during the duration of the trial. Sometimes, as much as 3-4 inches of rain fell in a week. But the disease control given by the fungicide was the same whether it was not washed or washed at an interval of 7-8 and 15-16 minutes after the application of the fungicide It was, therefore, clear that once the fungicide spray had dried on the leaf surface it resisted the washing action of rain which fell subsequently, thus confirming previous findings (1).

SUMMARY

The effect of washing Blitox '50', a fungicide containing 50% copper oxychloride, immediately after spraying and at various intervals after application on tea plants, on control achieved against blister blight infection, was investigated. Fungicide treated plants were individually subjected to the washing action of simulated rain, equivalent of 0.10 inches falling in 30 seconds.

Significant reduction in disease was achieved even when the fungicide sprayed on the plants, was subjected to washing either immediately or 2 – 3 minutes after application. A time interval of 7 – 8 minutes between fungicide application and washing, resulted in maximum protection given by the fungicide and no further significant increase in disease control was obtained when the time interval was increased to 15 – 16 minutes or even when no wash was given.

Optimum retention of the fungicide on the leaf surface, measured in terms of its efficacy in reducing blister blight incidence, was therefore achieved if no rain fell within the critical period, seven minutes under the conditions of the present experiment.

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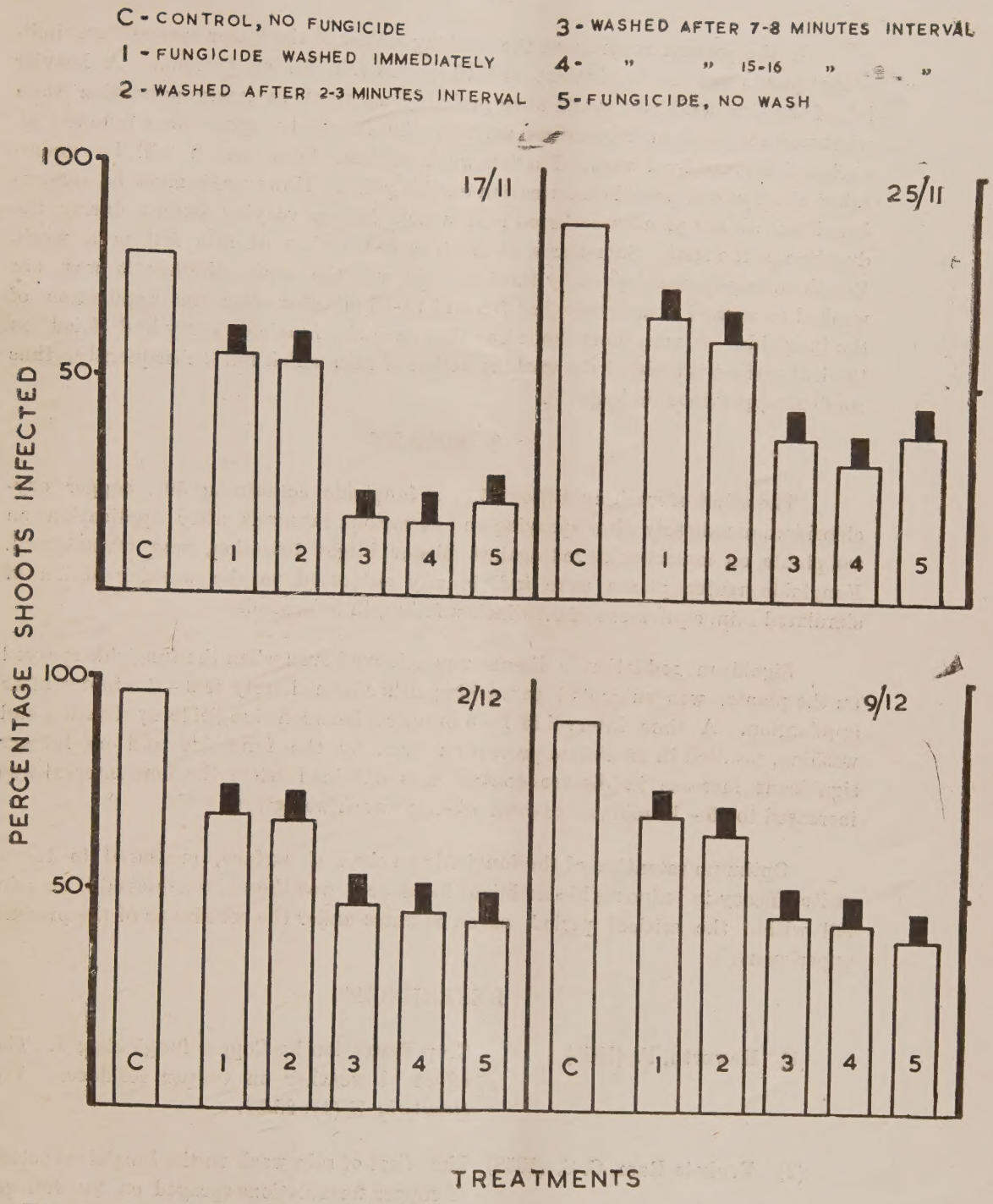

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Optimum retention of the fungicide on the leaf surface, measured in terms of its efficacy in reducing blister blight incidence, was therefore achieved if no rain fell within the critical period, seven minutes under the conditions of the present experiment.

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